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Sprays, Their Preparation and Use

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Sprays, Their Preparation and Use

By

R. H. Robinson

INTRODUCTION

The successful production of orchard and certain farm crops depends, in a large measure, upon the quality of the spray materials and the manner in which they are used to control insect pests and fungous diseases. The quality of both home-prepared sprays and the commercial product depends upon the care exercised and the procedure followed in the preparation of the spray material. In the preparation and use of home-made products, precautions must be closely observed or the effectiveness of the spray is greatly reduced. Likewise, in the use of commercial products, recommendations must be followed in order to obtain best results.

The introduction of new spray materials and the prevalent custom of employing combination sprays give rise continually to problems that must be solved in order to obtain best results in the orchard. Most of these troublesome problems are caused by chemical reactions that either reduce the efficiency of the spray materials or form a by-product that causes foliage burn or other harmful effects. A study of these chemical reactions under laboratory conditions has, in many instances, disclosed means of overcoming the difficulty.

The purpose of this bulletin is to outline proved methods for the preparation of those insecticides and fungicides that may be home-made and to emphasize the precautions that should be taken in order to insure best results. Also, general information is given regarding physical and chemical properties of the different commercial products. Their stability, compatability with other sprays, and effectiveness are commented upon.

Recommended combinations of two or more sprays. It is common orchard practice to combine two or even more different spray materials, mixing them in the spray tank and applying them as a unit. In order to retain the active principle of each insecticide or fungicide present in the combination, and to reduce danger of injury to foliage to a minimum, most combinations should be prepared by following a definite procedure. A compatibility chart is given on page 28 showing recommended combinations for the most important fungicides and insecticides used in the State of Oregon. More detailed information is given in Station Circular 68, describing specificially how each spray material should be added to the tank in the course of preparation.

ARSENATE OF LEAD

There are two forms of arsenate of lead that have been used as insecticides. They are known chemically as lead hydrogen or lead acid arsenate and basic or neutral lead arsenate. Investigations at the Oregon Experiment Station and in other states have shown that the lead hydrogen arsenate is more toxic to insect pests than basic lead arsenate, and consequently the production of the latter has been discontinued by many manufacturers. The basic lead arsenate, therefore, is rarely offered for sale in Oregon and if so it is plainly labeled to distinguish that form from the commonly used lead hydrogen arsenate.

High grade lead arsenate must be high in total arsenic for optimum killing efficiency, low in water-soluble arsenic in order that foliage burn may be reduced to a minimum, and free from foreign impurities. Since most manufacturers have perfected their processes for the production of lead arsenate, high grade material is the rule on the market. The chemical analyses of various brands of lead arsenate sampled in different parts of the state are given in Table I.

TABLE I. ANALYSIS OF DIFFERENT COMMERCIAL BRANDS OF LEAD ARSENATE

Name of manufacturer	Arsenic oxide total	Lead oxide total	Arsenic oxide water-soluble
	%	%	%
Acme White Lead and Color Works	32.2	64.4	.09
California Spray Chemical Co.	31.5	64.8	.04
Chipman Chemical Engineering Co.	32.0	63.4	.27
Devoe & Raynolds	32.9	64.0	.27
General Chemical Co.	31.4	63.4	.04
Lucas Kil-Tone Co.	31.7	63.6	.08
National Chemical Co.	30.6	63.4	.03
The Dow Chemical Co.	31.2	63.2	.20
The Grasselle Chemical Co.	31.5	63.0	.06
The Latimer-Goodwin Chemical Co.	29.2	64.4	.07
The Sherwin-Williams Co.	31.2	63.2	.12

The foregoing results indicate that there are only slight differences in the composition of the various brands. The low water-soluble arsenic content of all samples further emphasizes the high degree of purity of the commercial brands that are now on the market. We can conclude, therefore, from these and numerous other analyses, that from the standpoint of their chemical composition all present brands of lead arsenate are high grade and safe for general use.

Recommended combinations. Lead arsenate may be combined with bordeaux mixture, nicotine sulfate, "cold-mix" oil emulsions, and with lime-sulfur solution or any of the wettable sulfurs. Precautions to observe are as follows:

Lime-sulfur lead-arsenate combination. Fill the spray tank nearly full with water and add the required amount of lime-sulfur solution or other sulfur spray. Add either about two pounds of lime or one-half pound of casein spreader

to each 100 gallons of spray in the tank. Mix the lead arsenate with a little water and add the thin paste to the spray tank just before beginning spraying operations.

Nicotine-sulfate lead-arsenate combination. Fill the spray tank nearly full with water and add the required amount of nicotine sulfate. Add one pound of hydrated lime to each 100 gallons of the spray. Finally, just before beginning spraying operations, make a thin paste of the lead arsenate and pour it into the spray tank.

Nicotine-sulfate lime-sulfur lead-arsenate combination. Fill the spray tank nearly full with water and add the required amount of nicotine. Start the agitator and proceed as given under the lime-sulfur lead-arsenate combination.

Cold-mix oil-emulsion lead-arsenate combination. Fill the spray tank nearly full of water, start agitator, and add the required amount of the cold-mix oil emulsion. Finally, just before beginning to spray mix the lead arsenate with enough water to form a thin paste, and pour into the spray tank.

Bordeaux lead-arsenate combination. Prepare a full tank of bordeaux mixtures as given on pages 15-17. Add water to the required amount of lead arsenate to make a thin paste and pour into the tank just before beginning to spray.

CALCIUM ARSENATE AND PARIS GREEN

The demand for calcium arsenate in the State of Oregon is comparatively small since it can not be used safely as an orchard insecticide. This chemical is unstable, and the commercial product is somewhat variable in composition. If stored under unsuitable conditions, or in poor containers, chemical changes occur that result in a comparatively high water-soluble arsenic content that may cause injury to tender foliage. It is used advantageously as a garden insecticide, however, and has largely superseded paris green for this purpose. Calcium arsenate has also been found to be a very effective poison in several baits, such as those used for strawberry weevil, slugs, cutworms, etc.

Paris green is another arsenical that can not be used on tender foliage owing to its high water-soluble arsenic content. Like calcium arsenate, it is an effective poison in certain baits, and is recommended mainly for that purpose.

LIME-SULFUR

Lime-sulfur is the most important of the sulfur sprays. It is an efficient contact poison for certain scale insects and an important fungicide for several fungous diseases. When sulfur is combined chemically with calcium under certain conditions it forms calcium polysulfide, the principal active ingredient in lime-sulfur solution. The effectiveness of lime-sulfur solution as a dormant spray is largely due to the ability of the calcium polysulfide to take up oxygen.

Commercial lime-sulfur. Commercial brands of concentrated lime-sulfur solution are available in all of the fruit districts of the state. The different commercial brands vary somewhat in concentration, but for all practical purposes the strength of the different brands may be best indicated by means of a hydrometer that registers the density or Baumé reading. The different brands of commercial lime-sulfur offered on the Oregon market vary in density from 28° Baumé to 33° Baumé. It is therefore important for the orchardist to know the Baumé reading of the lime-sulfur solution in order that dilutions may be made in accordance with recommendations for specific spraying purposes. The orchardist is advised to test the lime-sulfur solution with a Baumé hydrometer and make dilutions for spraying in accordance with Table II.

The commercial brands of various dry lime-sulfur and sulfide products are discussed on page 4.

Home preparation of lime-sulfur solution. Care should be exercised in the preparation of lime-sulfur solutions in order to obtain as complete a reaction as possible between the lime and sulfur and to prevent the formation of excess sludge.

Chemical tests and practical trials have shown that lime and sulfur, when boiled in the proper amount of water, will go into solution best in the proportion of 1 part of lime to about 2 parts of sulfur. For the orchardist who makes his own lime-sulfur solution, the ingredients may be used in the following proportions:

Quicklime (stone lime)	50 pounds
Sulfur (finely ground or powdered)	100 pounds
Water to make finished product	50 gallons

To prepare small amounts. To prepare a small amount, 25 gallons for example, or half of the foregoing formula, the following procedure will be found most practicable:

1. Place in a large kettle or feed cooker 25 pounds of high-grade quicklime and add about 8 gallons of water.

2. When the lime is slaking vigorously, add 50 pounds of powdered sulfur and mix rapidly and thoroughly with the lime. Add water (preferably hot) gradually to prevent lime from drying out during the process of slaking.

3. As soon as all of the lime is well slaked and a uniform mixture of the slaked lime and sulfur has been obtained, add enough hot water to bring the total volume to 25 gallons. Bring to a boil quickly and continue boiling for 45 minutes. The boiling should be vigorous and continuous and the mixture should be stirred constantly throughout the operation. Hot water should be added at intervals to keep the volume at not less than 25 gallons.

4. The lime-sulfur may be cooled slightly and then strained through a 30- to 50-mesh screen (brass or tinned iron screen only should be used) into a storage container.

Lime-sulfur solution prepared in accordance with the directions previously outlined should have a Baumé test of not less than 27°.

To prepare large amounts. If steam is available quantities may be prepared limited only by the size of the vessel used. For a 100- to 200-gallon outfit, a single circular perforated steam coil may be placed near the edge and on the bottom of the vessel. A mechanical agitator with sweeping arms rotating on a shaft is fitted at the bottom and in the center of the vessel. Over this a half-inch-mesh wire screen cut to fit the vessel is supported by blocks about four inches above the bottom. The agitator revolves between this screen and the bottom of the vessel.

To prepare 100 gallons of the lime-sulfur proceed as follows:

1. Place 100 pounds of the quicklime on the screen and add sufficient hot water to start it slaking rapidly.

2. While the lime is slaking, add 200 pounds of powdered sulfur, mixing with a hoe, and add hot water as needed until the lime is slaked.

3. Add hot water to make a total volume of about 100 gallons, turn on the steam, start agitator, and cook about 45 minutes or until all of the free sulfur has apparently disappeared. During the boiling process add hot water occasionally, if necessary, to maintain a volume of 100 gallons.

4. The finished product is allowed to cool and after the sludge has settled the clear liquid may be drawn off into storage barrels.

The Baumé readings should be taken of each batch of lime-sulfur prepared and these readings plainly marked on the containers. The temperature of the lime-sulfur solution should be about 60° F. at the time the Baumé reading is recorded.

Precautions. It is important to use fresh, high-grade quicklime and to obtain powdered or very finely ground sulfur. Lime that has been allowed to stand around and become air-slaked cannot be used for the preparation of lime-sulfur solutions. If a low-grade or an impure quicklime is used, large amounts of sludge will be formed and sulfur will be wasted.

Overboiling or underboiling also increases the amount of sludge. After boiling about 30 minutes a sample of the lime-sulfur solution may be withdrawn, cooled quickly under cold, running water and the Baumé reading taken. If this shows approximately 27°, it should not be boiled much longer. On the other hand, if the Baumé reading is 25° or even less, the boiling should be continued the full length of time specified above.

Care should be taken to maintain the volume advised by the addition of more hot water. Hot water only should be added and it is better to add too much than not enough.

Recommended combinations. Lime-sulfur solution, either the home-prepared or the commercial product, may be combined with lead arsenate and nicotine sulfate in accordance with the directions given under lead arsenate.

Dilution of stock lime-sulfur solution. Every orchardist should obtain from the druggist a Baumé hydrometer in order that he may test his lime-sulfur solution, whether the home-made material or the commercial product. Unless this test is made, he will be unable to use the correct amount of water in diluting his spray for application.

When the Baumé reading of the lime-sulfur has been ascertained it may be diluted according to Table II.

TABLE II. DILUTION TABLE FOR LIQUID LIME-SULFUR

Strength of concentrated lime-sulfur solution		To make 100 gallons of dilute spray use the number of gallons of concentrated lime-sulfur indicated in the columns below, and add water to make 100 gallons.				
		1. Dormant strength for scale clean-up (5.2° Baumé)	2. Dormant strength for blister-mite and twig-miner (3.6° Baumé)	3. Early spring spray (1.7° Baumé)	4. Mid-spring spray (1.4° Baumé)	5. Late spring sprays (1.1° Baumé)
Degrees Baumé	Specific gravity					
		gallons	*gallons*	*gallons*	*gallons*	*gallons*
34°	1.304	11.1	7.5	3.1	2.3	1.8
33°	1.295	11.6	7.8	3.2	2.4	1.9
32°	1.283	12.0	8.0	3.3	2.5	2.0
31°	1.272	12.4	8.3	3.4	2.6	2.1
30°	1.261	12.8	8.5	3.5	2.6	2.1
29°	1.250	13.4	8.9	3.6	2.7	2.2
28°	1.239	13.9	9.3	3.8	2.8	2.3
26°	1.218	15.0	10.0	4.0	3.0	2.5
24°	1.198	16.4	11.0	4.4	3.3	2.8
22°	1.179	18.3	12.3	4.8	3.7	3.1
20°	1.160	20.8	13.8	5.4	4.2	3.5

COMMERCIAL DRY SULFIDE SPRAYS

Besides the lime-sulfur solutions, there are several commercial products in more or less common use. Among them may be mentioned dry lime-sulfur, barium-tetra-sulfide (B.T.S.), and soluble sulfur.

Barium-tetra-sulfide has been shown to be a fairly effective contact poison, but it possesses no distinct advantage over the lime-sulfur solution except that it is in powder form and convenient to handle. Its cost, however, is prohibitive, and consequently it has not been used to any extent in the Northwest.

Soluble sulfur is similar to lime-sulfur except that lye is used instead of lime in its preparation. As a dormant spray it has been found satisfactory, but it has no superiority over the lime-sulfur. It cannot be used as a summer spray or later than the dormant spray since it causes very severe foliage burn.

Dry lime-sulfur is the product obtained in the dehydration of the concentrated lime-sulfur solution. Apparently there is partial decomposition of the polysulfides during the process of manufacture since the percentage of both free sulfur and thiosulfate sulfur is higher and the polysulfide sulfur is lower than the amounts found in the concentrated lime-sulfur solution calculated on a dry basis. The most recent guaranteed composition of dry lime-sulfur at this writing is as follows:

	Percent
Calcium polysulfide	70.0
Calcium thiosulfate	5.0
Free sulfur	10.0
Inert ingredients	15.0

It may be considered therefore that, for summer spraying, 85 percent of the dry lime-sulfur consists of active ingredients and 15 percent of inert

materials that are of no value as a spray. For dormant spraying, however, the 10 percent free sulfur also is inert, while the 5-percent calcium thiosulfate has little or no value.

Summer spraying with dry lime-sulfur. The amount of dry lime-sulfur to use for summer spraying may be calculated on the basis of the foregoing analysis. For any bad summer infestation, such as scab, the amount of active ingredients present in a gallon of dissolved dry lime-sulfur should be equivalent to that present in a gallon of liquid lime-sulfur of any recommended strength. An average analysis for lime-sulfur solution, 32° Baumé, is as follows:

	Percent
Calcium polysulfide	30.5
Calcium thiosulfate	1.5
Water	68.0

A gallon of lime-sulfur 32° Baumé weighs about 10.7 pounds. Calculating the amount of active ingredients from these figures we find that there are 3.4 pounds per gallon.

When dry lime-sulfur is used either for the dormant spray or for the summer sprays it should be applied in amounts equivalent to the liquid lime-sulfur in order to obtain equivalent protection. Since each gallon of lime-sulfur solution contains 3.4 pounds of active ingredients it would take 4.0 pounds of a dry lime-sulfur having 85 percent active ingredients to be equivalent to one gallon of liquid lime-sulfur. Therefore, in making dilutions for the various sprays 4.0 pounds of the dry lime-sulfur should be used for each gallon of liquid lime-sulfur, Baumé 32°, necessary. While this amount is much higher than is recommended by the manufacturer, field experiments carried on in different parts of the country have indicated conclusively the need of using larger amounts than the manufacturers have recommended in the past, particularly when weather conditions favor the development of serious disease epidemics.

Dormant spraying with dry lime-sulfur. From the composition of dry lime-sulfur given above, a maximum of 70 percent only is of value for dormant spraying. Calculating on this basis, about 5 pounds of the dry lime-sulfur should be dissolved in 1 gallon of water to be equivalent to 1 gallon of liquid lime-sulfur, 32° Baumé.

For dormant spraying, scale clean-up, dry lime-sulfur should be used at the rate of at least 60 pounds to 100 gallons. This amount dissolves with difficulty and more than ordinary care must be exercised in order to bring the maximum amount of the dry lime-sulfur into solution. If 10 gallons or more of hot water is used, the dry lime-sulfur is dissolved more readily. The procedure suggested is as follows: Add 10 gallons or more of the hot water to the spray tank and start the agitator. Then sift in the dry lime-sulfur and add enough water to permit the agitator to rotate freely. Finally, turn on the cold water, filling the tank slowly in order to give time to dissolve all of the dry lime-sulfur. If these precautions are not taken, solid particles of the dry lime-sulfur will remain undissolved and will not adhere to the tree in that state. When undissolved, moreover, the solid particles are of no value as a dormant spray.

"WETTABLE SULFURS" FOR SUMMER SPRAYS

Mixtures in which sulfur is the active ingredient have been recognized for some time as the best summer fungicide. Until comparatively recently the self-boiled lime-sulfur was the standard spray used. This has been superseded by the "wettable sulfur" such as the Oregon cold-mix and the New Jersey dry-mix types. These forms have given effective control without causing spray injury or otherwise harming the plants or the crop.

Many commercial brands of wettable sulfur are available on the Oregon market. These are combinations of sulfur mixed with some substance such as casein and lime or glue that aids in wetting the sulfur when mixed with water. The quality of the different brands of wettable sulfur depends on the grade of sulfur used in the product. Very finely ground sulfur or high-quality flowers of sulfur produces the best wettable sulfur. In addition to the sulfur, the commercial brands contain varying amounts of hydrated lime, depending on the purpose for which they are to be used. For use on foliage susceptible to injury, brands containing an excess of lime should be used. For the more resistant foliage very little lime is necessary. If a commercial brand of wettable sulfur is to be used, the orchardist should ascertain for what specific purposes it is intended.

SELF-BOILED LIME-SULFUR

As stated above, the self-boiled lime-sulfur has been superseded by the wettable forms. Since the wettable sulfurs have given better results than the self-boiled lime-sulfur, the orchardist is advised to use one of the forms described below. Directions for the preparation of self-boiled lime-sulfur are therefore omitted.

OREGON COLD-MIX LIME-SULFUR

The preparation of Oregon cold-mix lime-sulfur may be accomplished with very little labor and by means of equipment ordinarily available on the farm. Less care perhaps is required to prepare the Oregon cold-mix lime and sulfur than for any other spray. It may therefore be mixed just before the time of application.

For making 50 gallons of spray, the following ingredients and amounts are recommended:

Sulfur (superfine)	8 pounds
Hydrated lime	4 pounds
Skim milk	2 quarts

The foregoing amounts may be proportionately increased or decreased depending on the quantity desired.

Preparation. 1. Weigh out the proper amount of sulfur and hydrated lime and mix them together.

2. Add an equal amount of water to 2 quarts of skim milk. Pour this on to the sulfur and lime mixture, stirring until a smooth paste is formed. Add enough water to form a very thin paste and pour through strainer into the spray tank.

3. Fill the spray tank with the required amount of water, and the spray is ready for application.

Precaution. In order to produce a good quality of spray, it is important that the sulfur should be ground superfine. If skim milk is not available, whole milk may be used with equal effectiveness. Dry skim-milk powder may also be substituted for the ordinary skim milk. The powder should be mixed with a little lime and dissolved in water at the rate of 4 ounces to each quart of water. This amount will be equivalent to 1 quart of skim milk.

DRY-MIX LIME AND SULFUR

The New Jersey Experiment Station has developed an excellent wettable sulfur that has given good results in field tests. The mixture is composed of the dry materials, which may be prepared at any time and used when necessary. The formula used for making 50 gallons of spray is as follows:

Sulfur	8 pounds
Hydrated lime	4 pounds
Calcium caseinate	½ pound

The foregoing amounts may be proportionately increased or decreased, depending on the quantity desired.

Preparation. 1. Weigh out the proper amounts of sulfur, hydrated lime, and calcium caseinate.

2. If necessary, sift both sulfur and lime through a small-mesh sieve in order to remove any lumps.

3. Mix together the three ingredients thoroughly in order to obtain a uniform mixture.

Dilution. The New Jersey Experiment Station recommends that the dry-mix material be used at the rate of 12½ pounds to 50 gallons of water. Any of the following methods may be used for diluting with water.

Method 1. Place the proper amount of material in a barrel, or other container which will hold water. Add water slowly, stirring the mixture until the grains of sulfur are wet and a thin solution is obtained that will pass readily through a strainer into the spray tank. Strain the material into the spray tank after filling it at least one-half full of water. This method is recommended particularly for use with hand outfits or where it is not convenient to have the agitator running when the tank is being filled.

Method 2. Wash the proper amount of dry-mix lime and sulfur through the strainer into the spray tank with the agitator running. This method can be used to advantage only where a strong flow of water from an overhead pipe or hose is available. The strainer used should not have more than 12 to 14 meshes to the inch.

Method 3. Put the proper amount of dry-mix directly into the spray tank after filling it at least one-half full of water. As in Method 2, the agitator should be running when the dry material is added in order to insure a thorough mixture with a minimum amount of settling. Open up the nozzle or spray-gun and drive a stream of the liquid that is being forced through the hose directly into the dry material as it falls upon the surface of the water in the tank.

RECOMMENDED COMBINATIONS

The Oregon cold-mix lime and sulfur and the New Jersey dry-mix lime and sulfur or any of the commercial wettable sulfurs may be combined safely with lead arsenate, nicotine sulfate, bordeaux mixture, or any of the cold-mix oil emulsions.

CALCIUM SULFIDE

Recent experimental tests by Hurt and Schneiderhan of the Virginia Experiment Station have shown that calcium sulfide may prove a valuable fungicide for summer spraying. Excellent results were obtained in the control of scab on apple trees.

The calcium sulfide used in experimental work was prepared by the reduction of anhydrous calcium sulfate. The product contained 65.0 percent calcium sulfide together with calcium sulfate and small amounts of other impurities. It is slightly soluble in water, but was found less caustic and gave less injury than some other summer fungicides.

Local experimental tests will determine the practicability of this fungicide under Oregon conditions.

BORDEAUX MIXTURE

Bordeaux mixture was for a long time the most widely used material for controlling fungous diseases of plants. It has been supplanted to a large extent by sulfur sprays and other materials; yet for certain diseases such as apple-tree anthracnose, peach-leaf curl, peach blight, potato late blight, celery blight, etc., bordeaux is still the most efficient and safest preventive known.

The effectiveness of most protective sprays depends to a large extent on the spreading and adhering properties of the materials. When bordeaux mixture is properly made it adheres well and has excellent spreading properties.

Commercial bordeaux mixture. Laboratory experiments confirmed by field tests have, in the past, shown the superiority of carefully prepared home-made bordeaux mixture over the commercial brands. During the last few years, however, the physical properties of dry bordeaux mixtures have been greatly improved, and recent field tests by the Oregon Station have shown that a few commercial brands possess adhesive qualities comparable to the home-prepared product.

There are on the market several commercial brands of powdered bordeaux mixture, the copper content of which ranges between 10 and 20 percent. Any of these may be used effectively on truck and garden crops, or for other purposes where it is not particularly important that the bordeaux adhere for long periods of time. It is advisable to use casein spreader wherever the commercial bordeaux is applied.

"Two-powder" commercial bordeaux. (Instant bordeaux.) In 1922 the Oregon Agricultural Experiment Station recommended for commercial manufacture a bordeaux preparation subsequently referred to as "two-powder" bordeaux. Recently this has been designated "instant" bordeaux.

Several commercial brands of this type of bordeaux mixture are available on the Oregon market, most of which have given good results.

The two-powder or instant bordeaux consists of two packages. One package contains powdered bluestone or copper sulfate, and the other contains hydrated lime. Either one or both of the packages may have mixed with the contents a small amount of casein. When the copper sulfate package is dissolved and the hydrated lime package is suspended in water and combined in accordance with the directions accompanying the product, an excellent bordeaux mixture is formed.

It has been found that some brands of the two-powder bordeaux mixture produce a poor grade bordeaux owing to the coarse particles present in the copper sulfate package. If coarse particles can be felt when tested by rubbing the powdered bluestone between the thumb and finger, a poor quality bordeaux will result that will not adhere well to foliage. If the contents of the lime package are a left-over from the previous year's stock, a poor grade bordeaux will likewise result.

Home-made bordeaux mixture. Carefully prepared home-made bordeaux mixture is unexcelled by any commercial brands available on the market. When properly made, a gelatinous, colloidal suspension of basic copper sulfate is formed which, if applied to the tree immediately after mixing, will adhere to the surface sprayed in appreciable amounts for several months. Recent field tests by the Oregon Agricultural Experiment Station have shown that more of the active ingredient, copper, adheres to the surface sprayed with home-made bordeaux than for any of the commercial brands tested.

The home-made bordeaux mixture is produced when a solution of copper sulfate (bluestone) and milk of lime are poured together. A chemical reaction takes place between the copper sulfate and the lime which results in the formation of a voluminous precipitate. In order to obtain optimum adhering qualities, the following method of preparation should be carefully observed. Otherwise a poor product will result.

Formulas are generally designated by the proportion of the material used. For example, the 4-4-50 formula is as follows:

4-4-50 Formula

Copper sulfate (bluestone)	4 pounds
Quicklime (stone lime)	4 pounds
Water	50 gallons

Other formulas have frequently been advised for specific purposes such as 3-3-50; 3-6-50; 6-6-50; 6-8-50; 5-5-50; and 8-4-50.

In recent years high-grade hydrated lime has been offered on the market. If properly used, it may be substituted for the quicklime. The highest-grade hydrated lime available is sometimes referred to as "chemical" hydrated lime in contrast to that used for general plastering purposes.

If the chemical lime is not available, however, the ordinary hydrated lime may be used. Tests have shown that when hydrated lime is used the milk of lime formed after the addition of water should be allowed to stand several hours or over night before using. When the hydrated lime is used,

about one-third more by weight than quicklime should be taken. The 4-4-50 formula then is as follows:

Copper sulfate (bluestone)	4 pounds
Hydrated lime	5½ pounds
Water	50 gallons

Other formulas likewise require one-third more of the hydrated lime than the quicklime.

Preparation of small quantities. If only a small amount of bordeaux mixture is needed, it may be prepared as follows:

1. Dissolve one-half pound of bluestone in three gallons of water.

2. Slake one-half pound of quicklime and add water to make three gallons.

3. Pour these two solutions together simultaneously into a third vessel. This will make six gallons of bordeaux mixture ready for use.

Preparation of larger quantities. If large quantities of bordeaux are to be used, it is best to prepare concentrated stock solutions of both copper sulfate and lime. A convenient concentration of each is one pound to a gallon of water and may be prepared as follows:

Stock solutions. (a) Copper sulfate when in lump form may be dissolved easily by filling a 50-gallon barrel about six inches from the top with water and suspending near the surface of the water 50 pounds of bluestone in a burlap sack. The bluestone will dissolve completely after standing about ten hours or overnight. If hot water is used the copper sulfate will dissolve in a comparatively short time. Good presoaked wooden barrels should be used. Iron containers can not be used since they are soon dissolved by the copper sulfate.

(b) To prepare the milk of lime, slake 50 pounds of quicklime in a barrel by the addition, with constant stirring, of enough water to prevent "burning" or drying of the lime. When thoroughly slaked, add water to make 50 gallons.

The stock solutions (a) and (b) will each contain one pound of material to one gallon of water. If covered to prevent evaporation they will keep indefinitely.

When hydrated lime is used instead of quicklime, weigh out 66 pounds and add enough water to make 50 gallons. This will contain the equivalent of one pound of quicklime to one gallon of water.

Copper sulfate may also be obtained in powdered form. When the powder is used, it is not necessary to prepare a stock solution since any desired amount may be dissolved quickly by sifting and stirring into the quantity of water to be used in making the bordeaux mixture. Since some brands of powdered copper sulfate are not finely ground, care should be taken to stir the solution until all of the particles are dissolved.

Method of preparation. Bordeaux mixture may be made in a satisfactory manner by several different methods. Whatever method is used it is most important that both the copper sulfate solution and the milk of lime be as dilute as possible before combining to form the bordeaux. The stock

solutions must never be mixed without first diluting with a large amount of water. The following method will give good results using the stock solutions described above. The following quantities are for the preparation of a 50-gallon tank of the 4-4-50 formula.

1. Fill the spray tank about half full of water and start the agitator.

2. Stir up the stock solution (b) of milk of lime thoroughly. Dip out four gallons and pour through a 20-mesh strainer into the spray tank.

3. Arrange the water inlet to the tank so that the water runs down a trough into the spray tank. Turn on the water full force in order to fill the tank as soon as possible.

4. Pour four gallons of the stock copper sulfate solution (a) into the trough slowly in order that it will be diluted as much as possible by the intake water.

5. The bordeaux is now ready for spraying. It should be applied immediately instead of allowing it to stand.

When larger quantities are to be prepared such as enough to fill a 300-gallon tank, multiple amounts of the milk of lime and bluestone are measured out, and the same procedure followed as described above. It is most important that the bluestone stock solution be poured into the intake water as it runs down the trough into the tank. In the preparation of a 300-gallon spray tank of the 4-4-50 bordeaux, 24 gallons of the milk of lime (b) and 24 gallons of the copper sulfate (b) solution will be required. As the last gallon of the copper sulfate solution is being poured into the trough with the intake water the tank should be nearly filled.

For every 50 gallons of tank capacity, with formulas other than the 4-4-50 formula, use as many gallons of the respective stock solutions as are called for in the formula.

Precautions. 1. Use fresh quicklime or hydrated lime of highest purity. If hydrated lime is used, add water and allow the milk of lime to stand several hours before using.

2. Dilute the stock solutions of copper sulfate and milk of lime in the manner described above.

3. Strain the milk of lime through a 20-mesh copper wire strainer before using.

4. Bordeaux mixture will attack iron. Rinse out spray tank, hose, and rod or gun with clean water immediately after using.

Preservative for bordeaux mixture. Bordeaux mixture must be applied immediately after preparation. If it is not possible to use all in the tank within an hour after it was made, the bordeaux may be preserved by the addition of a very small amount of ordinary sugar. The sugar retards the breaking down of the gelatinous precipitate that is so essential in the formation of a membrane that causes adherence to the surface sprayed.

The tests of the Oregon Agricultural Experiment Station indicate that $\frac{1}{8}$ oz. of sugar should be used for each pound of copper sulfate in the spray. For example, in a 100-gallon tank filled with 4-4-50 bordeaux mixture there were 8 lbs. of copper sulfate used. Therefore $8 \times \frac{1}{8}$ oz. or 1 oz. (1 heaped

tablespoonful) of sugar should be used. The required amount of sugar is added after first dissolving it in a little water.

Combination with other sprays. Bordeaux mixture may be combined safely with lead arsenate, calcium arsenate, paris green, certain mineral oil emulsions, and nicotine sulfate preparations.

When preparing the combination spray always add any of the foregoing materials to the bordeaux mixture after starting the agitator and just before application.

Mineral oil emulsion should be mixed with two times its volume of water before adding *slowly* to the bordeaux mixture.

BURGUNDY MIXTURE

This spray is sometimes used in place of bordeaux in sprays for small fruits shortly before picking because it does not leave the objectionable deposit on the fruit which comes from applying bordeaux at such a time. Like bordeaux, the active principle is copper but the mixture does not adhere as well as bordeaux.

Preparation. Burgundy mixture may be prepared in the same manner as bordeaux except that sodium carbonate is substituted for quicklime. The following formula is commonly used:

Copper sulfate (bluestone)	2 pounds
Sodium carbonate (sal soda)	3 pounds
Water	100 gallons

MINERAL OR LUBRICATING OIL EMULSIONS

The use of mineral or lubricating oil emulsions, both as dormant and summer sprays, has come into prominence within the past few years. Recent investigations have shown that the selection of an oil for specific purposes is important. An oil suitable for dormant spraying may cause severe injury if used as a summer spray. Some summer oil sprays may cause injury to the fruit in one locality while they may be used safely in another. Latest recommendations, therefore, should be obtained from the Agricultural Experiment Station regarding the different brands of commercial oil emulsions available that may be used with safety in the various fruit districts of the state.

When oil sprays are to be home-prepared it is likewise very important that the orchardist learn what kind and grade of oils may be used safely for the purpose intended.

PREPARATION OF OIL SPRAYS

It is generally known that oil and water alone will not mix. In order to break up the oil mass into globules that will disperse throughout the water an "emulsion" is made with the help of a third substance. This substance is referred to as an emulsifying agent. Among the emulsifying agents are included soap, calcium caseinate, bordeaux mixture, gums, colloidal clay, and others. When a definite amount of the oil, emulsifier, and water are mixed as described below, the oil emulsion is formed. If

properly prepared, the emulsion may then be added to the spray tank and dispersed in a suitable quantity of water in a manner similar to the mixing of other sprays.

The terminology commonly used when referring to the various types of oil sprays is sometimes confusing. For the purpose of differentiation, the oil sprays may be classified as soap emulsions and non-soap emulsions. The "boiled" emulsion is a type having soap as the emulsifier. "Miscible oils" may be described as a modified soap emulsion in that cresylic acid is used in addition to the soap to prepare the emulsion.

The non-soap emulsions are known as "cold-mix" emulsions since heat is not used in the process of preparation. When calcium caseinate, protein, bordeaux mixture, and certain other emulsifiers are used as the emulsifying agent, the spray produced is often referred to as a "quick-breaking" type of emulsion. In contrast to the soap emulsions, which are very stable, the quick-breaking emulsions separate into their component parts immediately following contact of the spray with the surface of the tree. Most of the oil adheres while the water drips off.

METHODS OF PREPARATION

In the preparation of various emulsions according to the following formulas, care should be taken to measure carefully the amounts of the different ingredients specified. The directions should be followed as closely as possible in order to obtain a good product.

Boiled emulsion—

Formula 1

Lubricating oil	2 gallons
Potash, fish-oil soap	2 pounds
Water	1 gallon

1. Dissolve the potash soap in the water by heating it in a kettle or other suitable vessel that will stand fire.

2. Add the oil and heat to the boiling point.

3. Remove kettle from fire and while still hot pump the mixture into another vessel with a bucket pump or through a spray pump at a pressure of about 60 pounds and then pump it back again.

The emulsion, after cooling, is ready for diluting and should mix well with water. If it does not mix well with water repump it.

Bordeaux emulsion—

Formula 2

Lubricating oil	4 gallons
Copper sulfate (bluestone)	½ pound in 1 gallon water
Calcium oxide (quicklime)	½ pound in 1 gallon water

1. Pour the lubricating oil into the empty spray tank, barrel, or other convenient vessel.

2. Combine the copper sulfate solution and milk of lime by pouring them together, simultaneously, into a third vessel, thus forming a freshly prepared bordeaux mixture.

3. Pour this freshly prepared bordeaux on to the oil in the spray tank and pump the mixture back into itself, using a pressure of 200 pounds or more. Continue pumping until a smooth emulsion is formed.

It is important that freshly prepared bordeaux mixture be used, or a poor emulsion will result.

Stock solutions for formula 2. If several tanks of spray are to be used during the day, stock solutions of both copper sulfate and lime will facilitate the preparation of the oil emulsion. The stock solution may be prepared as directed under bordeaux mixture, except that ½-pound of each material is dissolved in 1 gallon of water.

Skim-milk emulsion—

Formula 3

Lubricating oil	4 gallons
Water	1 gallon
Skim milk	1½ quarts
Hydrated lime	1 ounce

1. Pour the lubricating oil into the spray tank, half barrel, or other convenient vessel.

2. Add the skim milk to the gallon of water and stir in the hydrated lime or its equivalent of slaked quicklime.

3. Pour this mixture on to the oil and pump it back into itself at a pressure of 200 pounds or more. Continue pumping until a smooth emulsion is formed.

Casein emulsion—

Formula 4

Lubricating oil	4 gallons
Water	1½ gallons
Casein spreader	½ pound

1. Pour the lubricating oil into the spray tank, half-barrel, or a convenient vessel.

2. Make a smooth paste out of the casein spreader by slowly adding water and stirring. Continue adding the water until 1½ gallons have been added.

3. Pour this mixture on to the oil and pump it back into itself at 200 pounds pressure or more. Continue pumping until a creamy emulsion is obtained.

Kerosene emulsion—

Formula 5

Kerosene	4 gallons
Water	2 gallons
Casein spreader	½ pound

1. Pour the kerosene into the spray tank, half-barrel, or other container.

2. Make a smooth paste out of the casein by slowly adding water and stirring to remove lumps. Continue adding water until 2 gallons have been added.

3. Pour this mixture into the kerosene and pump it back into itself until a smooth, creamy emulsion is obtained.

Precautions in the use of oil emulsions. The emulsions formed from these different formulas are concentrated and must be diluted with water before using. If the emulsions have been prepared properly they will disperse readily in water, mixing evenly throughout very much as milk mixes with water.

If the emulsion is not properly made or if a "reverse" emulsion is formed, it will not disperse in the water but, like oil, will float on top of the water. When this occurs the broken emulsion or reverse emulsion, as the case may be, should be discarded since it would cause severe injury if applied to the tree without being properly emulsified.

Ordinarily the cold-mixed emulsions are fairly stable and if properly made may last for weeks. It is generally advisable, however, to use them immediately after preparation.

Combination of cold-mixed lubricating-oil emulsion with other sprays. The cold-mixed oil sprays, formulas 2, 3 and 4, may be combined safely with bordeaux mixture, lead arsenate, nicotine sulfate, and the cold-mixed lime and sulfur or other wettable sulfur preparations. It is not advisable to mix them with liquid lime-sulfur, or with the commercial dry lime-sulfur. When conditions require this combination write to the Chemistry department of the Agricultural Experiment Station for details regarding the procedure to follow.

MISCIBLE OILS

The so-called commercial miscible oils are used mainly for dormant sprays. They should not be used in summer sprays since the emulsifying agent, cresylic-acid soap, will react with the lead arsenate and cause foliage injury.

A very concentrated miscible oil results when commercial cresylic acid or cresol and a soft potash soap are mixed with lubricating oil in definite proportions. The potash soap should contain about 30 percent moisture. The soap will combine with cresylic acid and form a liquid product. This combination may then be dissolved in the lubricating oil.

Preparation of miscible oil. A concentrated miscible oil may be prepared from ingredients used in the following proportions:

Formula 6

Lubricating oil	5 gallons
Cresylic acid	1 quart
Potash fish-oil soap	2 pounds

1. The potash soap (described below) containing about 30 percent moisture and the cresylic acid are carefully stirred together.

2. The mixture is then poured into the lubricating oil and stirred until a homogeneous liquid is obtained.

Precautions in making and using concentrated miscible oil. As stated above, potash soap containing about 30 percent water should be used. Soda soap cannot be used. The potash soap should not contain much free alkali.

Special care should be taken in diluting the concentrated miscible oil, either the commercial brands or the home-made product, for spraying. The amount of miscible oil to be used should be measured out and an equivalent quantity of water added. The water should be added in small amounts at

first, with constant stirring. This emulsion of concentrated miscible oil and water may then be poured into the spray tank already filled with water. The agitator of the spray tank should be in motion during the process of adding the diluted miscible oil.

Miscible oil may be used successfully where soft water is available. If the water is hard it may cause a breaking of the emulsion, resulting in the oil separating and floating to the top of the water. If the water is not too hard, two or more pounds of soap may be dissolved in hot water and added to the tank of water before the miscible oil is added. This then may be followed by the addition of the diluted miscible oil. If the water is very hard, one of the cold-mix lubricating-oil emulsions, previously described, should be used instead of the miscible oil.

Preparation of miscible oil emulsion. Instead of preparing a concentrated miscible oil, as described above, an emulsion containing a larger amount of water may be more easily made, using the same formula as No. 7. The procedure is as follows:

1. Stir the commercial cresylic acid and soap together until a homogeneous mixture is obtained. This is then dissolved in two gallons of water.

2. Pour the oil into the spray tank, half barrel, or other container, and add the cresylic acid and soap mixture.

3. Pump the mixture back into itself until a smooth, creamy emulsion is obtained. This emulsion may then be diluted with water without taking the extraordinary precaution necessary in diluting concentrated miscible oil.

FISH-OIL SOAPS

Fish-oil soap, often mis-called whale-oil soap, is used extensively in agriculture both as an insecticide and as a spreading agent for certain spray materials. While a pure whale-oil soap may be obtained commercially, most of these soaps are prepared from oil extracted from the refuse of fish canneries. Whale-oil soap is not superior in any way to the mixed fish-oil soap.

The commercial fish-oil soap is available both as the potash and as the soda soap. A potash fish-oil soap, containing about 70 percent dry soap, is soft and jelly-like. The soda fish-oil soap, on the other hand, is hard and is usually wrapped in paper like laundry soap.

Potash fish-oil soap. The potash fish-oil soap may be prepared from the following formula:

Formula 7

Fish oil	1 gallon
Caustic potash (potassium hydroxide)	1½ pounds
Water	3 pints

The caustic potash is dissolved completely in the water by warming. The fish oil is then gradually added with vigorous stirring. The mixture is finally heated for a short time with thorough stirring until the mass is uniformly smooth.

COMMERCIAL NICOTINE COMPOUNDS

Nicotine compounds for insecticidal purposes are available on the market in numerous forms. Many nicotine dusts and proprietary mixtures are compounded for special purposes. The most important commercial product, however, is a water solution containing 40 percent of nicotine as nicotine sulfate. These are known by the trade names Black Leaf 40, Ortho nicotine, and N. P. C. nicotine. There is also the less commonly used nicotine solution, which is composed of 40 percent free nicotine. The nicotine-sulfate solution is comparatively stable and will last indefinitely if protected from evaporation. The free nicotine, on the other hand, must be tightly sealed or loss will occur by volatilization.

The 40-percent solution of either nicotine sulfate or free nicotine is used ordinarily at the rate of 1 pint to 100 gallons of water. When used in orchard spraying, one pound of casein spreader to 100 gallons of the nicotine spray should be added to increase the spreading and wetting action. It is also advisable to add one or two pounds of hydrated lime to each 100 gallons of spray to increase the volatility of the nicotine.

The various proprietary spray mixtures that contain nicotine are often of very little value. Usually they are simply the 40-percent nicotine-sulfate solution diluted with water and combined with small amounts of other spray ingredients. When such mixtures are diluted in accordance with recommendations on the package for spraying purposes, the active ingredients have been so diluted that they have comparatively little value for the purpose intended.

Home preparation of nicotine dusts. Nicotine dusts may be home prepared by adding, in the required proportion, either the commercial nicotine sulfate or the solution of free nicotine to carriers such as sulfur, hydrated lime, gypsum, or other fillers. The Chemistry department of the Oregon Agricultural Experiment Station will give details regarding the procedure to follow in compounding these dusts and other information pertaining to mixing-machines and machinery available for making dust for orchard dusting.

Small amounts of nicotine dusts for garden use may be prepared by simply stirring one-fourth pound of free nicotine solution into about five pounds of either sulfur or hydrated lime. Care should be taken to crush all lumps in order that the nicotine may be uniformly mixed throughout the batch. The 40-percent nicotine-sulfate solution may be used instead of the free-nicotine solution, but it is somewhat more gummy and forms more lumps.

Lead arsenate, dry bordeaux powder, or other dry insecticides or fungicides may be mixed with the foregoing prepared nicotine dust if desired for general garden use. It is best to use the nicotine dusts within a week after they have been prepared.

Nicotine dusts may be used advantageously for the control of aphids and certain other insects in both orchards and gardens. Climatic conditions in each locality should determine the practicability of using the nicotine dust on a large scale in orchard practice. For the control of insects in the truck gardens, however, the dusting method is often superior to spraying.

PARADICHLOROBENZENE

Paradichlorobenzene is an excellent soil insecticide and fumigant. In orchard practice it has found wide use for the control of the peach and prune tree root-borers. On account of its physical and chemical properties, caution must be used in order to obtain satisfactory results and to avoid injury to the tree.

Paradichlorobenzene is a white crystalline chemical that is comparatively volatile at 70° to 80° F. It vaporizes more slowly at lower temperatures and if much below 70° the volatilization is too slow to be effective. The gas is more than five times as heavy as air and consequently it lends itself very well for the treatment of soil insects by penetrating downward and laterally under the soil.

Very small amounts of paradichlorobenzene are necessary to control soil insects. One ounce for young trees, ranging up to 3 ounces for large trees, is sufficient. Larger amounts than this are of no value and may cause injury, especially if placed too close to the trunks of the trees. In order to obtain best results, the soil should be moist but not water soaked since the gas will not penetrate a water-soaked soil. On the other hand, the gas would dissipate throughout a dry and porous soil too rapidly to give good control.

Station Circular 50 describes the method of control of the peach and prune root-borer.

PYRETHRUM

Pyrethrum is a potent insecticide that is very toxic to many insects. It is the active ingredient of many of the household fly sprays and dusts. The use of pyrethrum in the past has been limited, owing mainly to its cost. Recently, however, it has come upon the market in liquid form and is recommended for controlling aphids and various other insects. Its future use depends on cost and its relative effectiveness in the control of certain insects. Information regarding the latter will be supplied by the Entomology department of the Experiment Station.

FLUORINE COMPOUNDS

Numerous fluorine compounds comprising several fluorides, sodium fluosilicate, cryolite, barium fluosilicate, and others have been used successfully as insecticides under certain conditions. In some parts of the United States they have been recommended as substitutes for arsenicals in the control of certain insects.

In order to avoid the use of arsenicals on truck garden crops, certain of the fluorine compounds may prove effective. Recommendations for these substances may be obtained from the Entomology department of the Agricultural Experiment Station. None of these compounds can be used as an orchard spray in Oregon since experimental tests have resulted in severe foliage injury. Future developments, however, may overcome this difficulty and certain of the fluorine compounds may be of economic importance as general insecticides.

DERRIS

Derris root is another active insecticide for certain purposes. The extract of the derris root has given good control of certain pests such as the aphid and red spider. Owing to its cost, however, derris has not yet found a very wide practical use.

SPREADERS FOR SPRAY MATERIALS

The effectiveness of some sprays is increased by the addition of a harmless substance that will improve the wetting, spreading, and adhering properties of the spray material. Some plant surfaces and certain insects are wetted with difficulty, but if the proper kind of spreader is added to the spray a continuous film of the poison is deposited on the surface to be covered. For general use the casein-lime spreader or the skim-milk spreader is recommended. These materials have added value when correctly used in certain combination sprays described in Station Circular 68. The addition of the spreader to combination sprays retards the chemical action that destroys the individual components of the spray and diminishes the possibility of foliage injury.

Commercial spreaders. There are available on the Oregon market several commercial spreaders that may be used advantageously for specific purposes. The claims made by some manufacturers of benefits derived from the use of their product are sometimes exaggerated. Furthermore, some commercial spreaders may cause injury to foliage, or may influence the removal of the spray residue. It is therefore important that the orchardist ascertain whether a spreader can be used safely.

The casein spreaders have been on the market for several years. This spreader is a mixture of casein and lime and may be used safely when recommended. Other commercial spreaders are recommended only after at least one season's successful trial.

Home-prepared spreaders. Soap is an excellent spreader but cannot be used except in certain sprays. It increases the toxic action of the nicotine sprays but will cause severe foliage injury if used in an arsenical spray. It cannot be used with lime-sulfur solution or bordeaux mixture.

For use in aphid control of garden crops, the following combination will be successful:

Soap spreader

Fish-oil soap or laundry soap	4 pounds
Water	100 gallons

The soap is shaved into thin strips and dissolved in hot water. This is sufficient for 100 gallons of spray. (Never use this soap spreader with lead arsenate, lime-sulfur, or bordeaux mixture.)

A satisfactory spreader may be prepared by using skim milk. This may be prepared as follows:

Skim-milk spreader

Skim milk	3 quarts
Hydrated lime	6 ounces
Water	100 gallons

The hydrated lime is stirred into the skim milk. This mixture is then added to 100 gallons of spray. The skim-milk spreader may be used for all the purposes for which the casein-lime spreader is used.

A casein-lime spreader similar to the product available on the market may be prepared as follows:

Casein-lime spreader

Casein, powdered	5 ounces
Hydrated lime	10 ounces
Water	100 gallons

The hydrated lime is thoroughly mixed with the casein and water is slowly added to form a thick paste. Care should be taken not to add too much water at first since lumping will occur. After stirring until all lumps are removed, more water is added to make a very thin paste.

This is sufficient spreader for 100 gallons of spray.

Precautions in the use of spreaders. When using any spreader material, care should be taken to add the required amount recommended for the purpose intended. Since the use of the spreader is limited, the orchardist should ascertain for what purposes it is recommended.

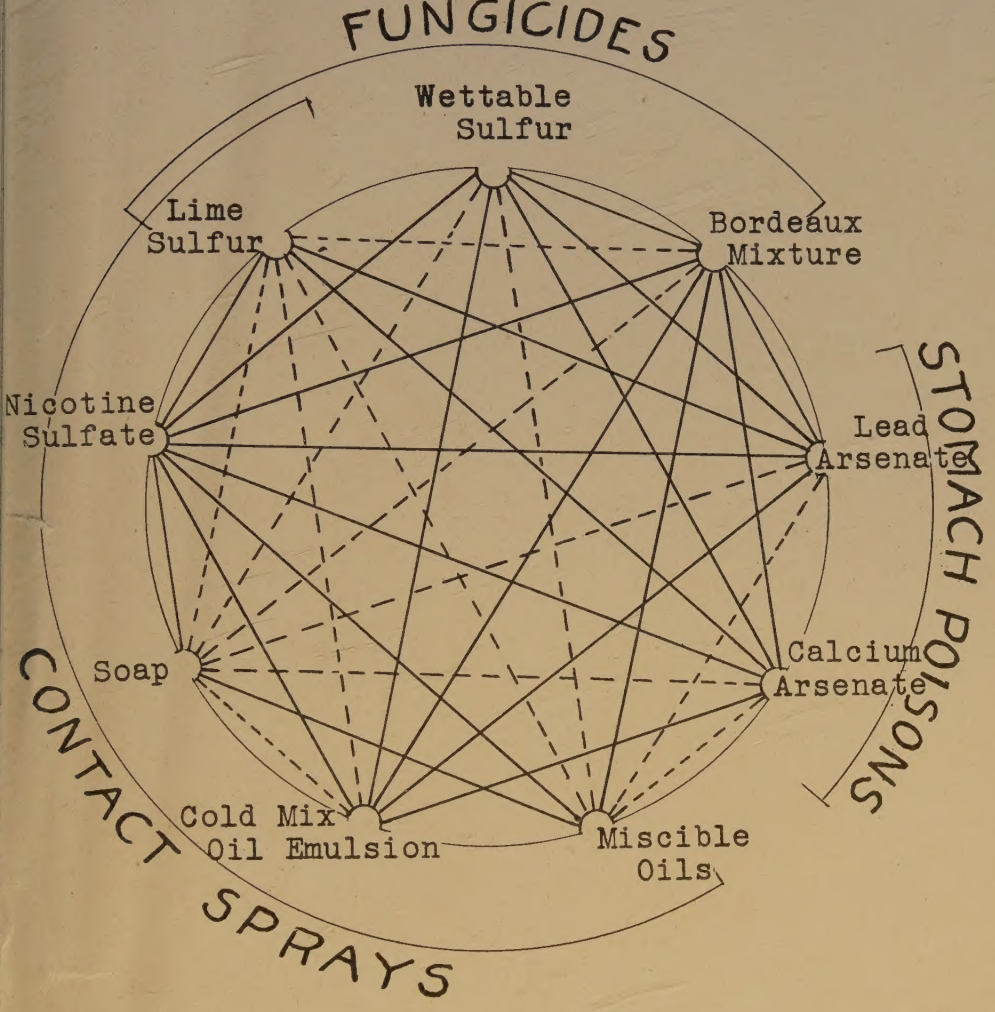
FISH-OIL ADHESIVE

Recent experimental tests have shown that fish-oil is an excellent adhesive for those sprays that consist of solid materials, such as arsenate of lead. It should be classified primarily as an adhesive agent and not as a spreader. It may therefore be used only for purposes where the adhesive is recommended. It should not be used, for example, in the late lead-arsenate cover sprays since it would prevent the effective cleaning of the residue from the fruit by the washing process. As further experimental data are obtained, more definite recommendations will be made regarding the use of fish-oil adhesives.

For sprays containing about 2 pounds of the poison to 100 gallons of water, such as lead arsenate, the fish-oil may be used at the rate of 1 pint of oil to 100 gallons of spray. This amount will leave no free oil to rise to the surface of the water. If the fish-oil adhesive is to be used in a bordeaux mixture, for example the 4-4-50 mixture, about 1 quart should be used to 100 gallons of spray.

Compatibility Chart

This chart indicates what commonly used insecticides and fungicides may be mixed safely in the spray tank. Materials connected by dotted lines should not be combined. Those connected by unbroken lines may be combined safely.



———— RECOMMENDED COMBINATIONS

— — — — — — DANGEROUS COMBINATIONS